THE INSECT PEST SURVEY BULLETIN

Volume 15 Supplement Number 3

BUREAU OF
ENTOMOLOGY AND PLANT QUARANTINE
UNITED STATES
DEPARTMENT OF AGRICULTURE
AND
THE STATE ENTOMOLOGICAL
AGENCIES COOPERATING

I N S E C T P E S T S U R V E Y B U L L E T I N

Vol. 15 Supplement No. 3

TRIAL SURVEYS OF CHINCH BUGS IN HIBERNATION, NOVEMBER 1934 TO MARCH 1935

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Purpose of Surveys

The studies reported herein were made during the winter of 1934-35 in the vicinity of Lafayette, Ind., to gain information on winter survey methods and to obtain estimates of chinch bug abundance in hibernation quarters for comparison with surveys of the same areas at other times of year. The ultimate objective is to determine the comparative practicability and dependability of fall surveys in standing corn, winter surveys in hibernation quarters, and spring surveys in small grains, as bases for forecasting chinch bug abundance in corn the following summer.

Method of Sampling

For the purposes of this study it appeared essential that the total number of bugs present in each sample be determined. Therefore, on account of the large numbers of bugs and large amount of material contained in square-foot samples, it was necessary to reduce the size of the sample materially in order to handle the number desired with the time and help available. It also seemed essential to have the individual samples completely made up of the particular hibernation medium being sampled, a thing very difficult to do if square feet were taken, as samples that large unavoidably include variable quantities of extraneous material. For these reasons, the size of sample was set at 1/5 square foot, the area enclosed by a wire or sheet-iron ring of 6-1/16 inches in diameter. This size was used throughout the survey trials, except for two series of 1-square-foot samples taken from woodland leaves and litter, and one series of 1-square-foot samples taken from big bluestem grass for comparison with 1/5-square-foot samples taken from the same locations. The sampling was further restricted as far as possible to well-drained south and west exposures, the locations where bugs were most likely to be found.

Several methods were used for extracting the bugs from the samples. (1) Direct dissection over a large sheet of oilcloth or paper, removing and counting the bugs as they emerged or were uncovered. (2) Direct dissection and sifting, first with a fine sieve to remove soil, then with a coarse sieve to remove the coarse litter, and finally counting and removing bugs as they emerged or were uncovered from the remainder. (3) Use of Berlese funnels under steam pipes to drive bugs by means of heat into collecting jars containing alcohol. (4) Submergence and dissection of sample in a tub of water to float out the bugs. For lightly infested samples methods 1 and 2 were best, but for heavily infested samples methods 3 and 4 were preferable.

Variation among Individual Samples

The numbers of bugs in individual samples were extremely variable, even when taken from the same kind of grass and as nearly as possible from the same location. For instance, six 1/5-square-foot and six 1-square-foot samples, all taken from big bluestem grass within 100 yards along a well-drained southward sloping roadside, varied as follows:

Size of sample	Bugs per sample		
	Minimum	Maximum	Average
	Number	Number	Number
1/5 square foot	14	236	107
1 square foot	282	3,169	916

Further evidence of the extreme variability in numbers of bugs in individual samples is given in the following comparison between 1/5-square-foot and 1-square-foot samples. Twenty-five pairs were taken from the most favorably located clumps of big bluestem in a fairly uniform area about 2 miles square, each pair consisting of adjacent 1/5-square-foot and a 1-square-foot samples from the same clump of grass, with the following results:

Size of sample	Bugs per sample		
	Minimum	Maximum	Average
	Number	Number	Number
1/5 square foot	1	2,863	340
1 square foot	49	3,169	676

Notwithstanding efforts to take the above samples from as uniform an environment as possible the variation between those of either size was very great. The data were analyzed by the usual statistical methods but the results are not given here because the methods of analysis commonly used were apparently not applicable to this experiment. The distribution of chinch bugs in hibernation is so uneven that a great many more and also much larger samples, perhaps entirely on an area basis, irrespective of host plants, would probably be necessary before the data would approach anything like a

normal distribution susceptible of the usual statistical treatment. Such an experiment would be time-consuming and of little, if any, practical value.

Although the 1-square-foot samples varied less among themselves in this experiment and hence were possibly more reliable indicators of population than the 1/5-square-foot samples, there is probably not enough difference in variation to justify the increase in work involved in their examination. Furthermore, reducing the size of the sample makes it possible to handle a larger number of them per given area in the time available, probably affording better chances of finding bugs if present.

The 1/5-square-foot samples also indicated a much higher infestation than did the 1-square-foot samples. Probably this would be generally true because the smaller samples would naturally be taken from the best parts of the grass clumps, while the larger samples would necessarily include a varying amount of the sparse vegetation less likely to harbor bugs. This very limited experiment would indicate that the number of bugs per 1/5 square foot should be multiplied by two instead of five, to give the infestation to be expected in 1-square-foot samples composed entirely of grass. This relationship would undoubtedly be variable, depending on kind of grass, method of sampling, and other factors.

Replicated Survey of Tippecanoe County

Between November 22 and December 14, 1934, 180 1/5-square-foot samples were taken in Tippecanoe County, 20 being taken from each of the 9 areas sampled during the previous fall survey in standing corn, the entire county being roughly divided into three rows of 3 areas each. The sampling was restricted to well-drained south and west exposures and to the bunch or tuft-forming grasses, exclusive of timothy. The most favored grasses were not present throughout all the areas, hence it was necessary to take the samples from the best ones available. Twelve species were involved, the number of samples being as follows: Andropogon furcatus, 81; Andropogon scoparius, 2; Elymus canadensis, 19; Elymus virginicus, 15; Elymus striatus, 24; Sporobolus asper, 15; Tridens flavus, 4; Panicum virgatum, 13; Atheropogon curtipendulus, 2; Hystrix hystrix, 1; Sorghastrum nutans, 3; Spartina michauxiana, 1.

The number of chinch bugs in each sample was determined and the data were made up into 20 sets, each set including 1 sample from each of the 9 areas so as to be representative of the entire county, no sample being used in more than 1 set. Thus each representative county sample was a completely independent set of 9 1/5-square-foot samples. The results are summarized as follows: Number of 1/5-square-foot samples in county sample, 9; number of county samples, 20; average number of bugs per 1/5 square foot in county samples, minimum, 57; maximum, 358; mean, 140.

It is seen at once that the average number of bugs per county sample varied greatly, notwithstanding the attempts to reduce variation by restriction of the sampling to the most favorable host plants and exposures. Statistical analysis of these county samples by the usual methods was found to

be futile for the reasons already stated with reference to individual 1/5-square-foot samples, and the results are therefore not reported here. About all that can be said for the 20 replications in this experiment is that, although they varied greatly among themselves, they all showed infestations far above the level of 15 per square foot, established by the Illinois workers as indicative of abundant infestation. Assuming bugs present in the 1-square-foot samples to be double the number in the 1/5-square-foot samples, for reasons already explained, this experiment indicates the presence of about 280 bugs per square foot of bunch grass in the most favorable locations in Tippecanoe County.

Averaging the sets of 20 1/5-square-foot samples taken from each area indicated considerable variation in abundance of hibernating bugs in different parts of the county, as would be expected from the topography, which ranges from natural prairie with black soil, much corn, and bunch grass, to broken, more or less wooded country with more uncultivated land, gravelly or clay soil, more varied crops, less corn, and less bunch grass. The infestations by area were as follows:

Area	Type	Favored grasses	Bugs per 1/5 sq. ft.
			Number
Northwest	Prairie	Abundant	393
West Central	Mixed	Common	94
Southwest	do.	do.	136
North Central	do.	do.	132
Central	do.	do.	157
South Central	do.	do.	84
Northeast	Broken	Scarce	63
East Central	do.	do.	126
Southeast	Mixed	Common	74

Surveys of Other Counties and Comparative Abundance of Bugs in Different Media

In addition to the replicated hibernation survey in Tippecanoe County, single surveys were made in the three neighboring counties covered last fall while the bugs were still in the cornfields. At least one 1/5-square-foot sample was taken from each ninth of a county and from each medium used. More than one set of samples of certain media were taken in some counties, for one reason or another, but all samples of each medium are combined in the following averages. One-square-foot samples were taken of the woodland types of cover, the results being divided by five for entry in the following table of results in terms of bugs per 1/5 square foot.

Hibernating media	Average bugs per 1/5 square foot, by counties			
	Benton	Tippecanoe	Clinton	Tipton
	Number	Number	Number	Number
All grasses	221	131	55	21
Bunch grasses, except timothy	288	140	28	47
Timothy	76	92	76	7
Bunch-type sedges	--	15	17	5
Mat-type sedges	--	--	--	10
Bluegrass	--	4	--	--
Volunteer wheat	--	2	--	--
Woodland leaves and litter	--	5	--	--
Woodland leaves and litter, plus small grass or sedge tufts	--	10	--	--
Fall survey in corn, bugs per stalk	13	10	4	0.3

These figures indicate infestation to be in the "abundant" range of 15 or more bugs per square foot in all four counties, even in the less favorable media. The above table gives at least a rough idea of the actual numbers of bugs present in the different types of cover in this year of extreme abundance. However, proper evaluation of different media would require data for years and areas of greater scarcity. In a general way, the comparative abundance of bugs in the different counties is similarly indicated by the different media, but determination of the actual infestation level evidently requires different indices for different media. That is, abundant infestation may perhaps be indicated by 15 bugs per square foot in the favored bunch grasses, 8 per square foot in timothy, 3 per square foot in bunchy sedges, 1 per square foot in woodland leaves, or from 10 to 15 per stalk in corn before fall migration. The meaning of certain infestation levels in different hibernation media is doubtless also affected by the comparative abundance of the different types of cover in different areas. However, the numbers of bugs present in small samples of any medium are so variable that much more extensive sampling than was possible in these experiments would be necessary to determine these points conclusively.

The time involved in taking and examining samples depends on several factors, such as condition of country and roads, type and abundance of hibernating media, number and size of samples, degree of infestation, and completeness of count. One man with an automobile could probably average two counties or more per day in practical survey work, taking 9 samples per county and not stopping to make counts. Complete counts of all bugs in samples might require several days per county, but by discarding samples as soon as enough bugs were found to determine the infestation level the work could be much shortened and under favorable conditions could be done at once in the field. Judging from these trials, a great many more than 9 1/5-square-foot or 1-square-foot samples would have to be taken in order to obtain more than a rough idea of chinch bug abundance in a county, in fact many more samples than would be possible with the funds ordinarily available for such work.

Comparative Numbers of Chinch Bugs Hibernating in Different Grasses

The work of obtaining information on hibernation in different grasses was greatly facilitated by Philip Luginbill's knowledge of the species of grasses encountered. We were very fortunate in having his assistance with the field work and identification of grasses. In determining the comparative abundance of bugs in different kinds of grasses Andropogon furcatus (big bluestem) was used as the standard, this grass being rated at 100. The rating of each grass was determined by comparing the average infestation in all the samples of that grass taken from the various areas with the average infestation in all the samples of A. furcatus from the same areas. For instance, the average infestation in the 6 samples of T. flavus was 152, and the average infestation in the 23 samples of A. furcatus from the same areas was 141. The rating of T. flavus was therefore 141:152::100:x, or 108. Certain grasses were more prevalent than others in different areas and it would have been obviously incorrect to make comparisons of the infestation in a species of grass in one locality with the infestation in another species under the different ecological and infestation conditions prevailing in another locality. All samples were taken from the most favorable exposures available. The woodland samples were all 1 square foot and were taken at or close to south edges of such areas. Some of the species represented by only one or a few samples may be far out of place, otherwise the rating below is thought to be fairly accurate for this year and region.

Hibernating media	Rating 1/	Samples: Number	Average bugs per 1/5 sq. ft.: Number
Andropogon scoparius (little bluestem)	223	10	254
Tridens flavus (tall redtop)	108	6	152
Andropogon furcatus (big bluestem)	100	108	198
Sporobolus asper (long-leaved rush-grass)	93	18	127
Atheropogon curtipendulus (tall grama-grass)	78	2	58
Hystrix hystrix (bottle-brush grass)	74	1	87
Elymus canadensis (nodding wild rye)	58	33	118
Elymus virginicus var. submuticus	58	1	69
Elymus virginicus (Virginia wild rye)	50	9	146
Sorghastrum nutans (Indian grass)	50	7	56
Dactylis glomerata (orchard-grass)	46	3	119
Phleum pratense (timothy)	43	57	86
Bremus inermis (awnless brome-grass)	41	1	30
Elymus striatus (slender wild rye)	37	34	47
Elymus striatus var. arkansanus	36	2	40
Panicum virgatum (switch-grass)	22	15	62
Sedges (clump type)	9	25	16
Spartina michauxiana (tall marsh-grass)	9	1	11
Sedges (sparse or running type)	8	13	9
Elymus virginicus var. jejunus (western wild rye)	5	10	7
Woodland leaves and grass	5	10	10
Agropyron repens (quack-grass)	3	1	2
Poa pratensis (Kentucky blue-grass	2	9	4
Woodland leaves	2	10	5
Volunteer wheat	1	19	2

1/ A. furcatus equals 100.

Winter Mortality

Samples taken periodically from locations near Lafayette gave the following results:

Hibernating media	January 7		February 1		February 20		March 11		April 5-12	
	Total bugs	Dead bugs	Total bugs	Dead bugs	Total bugs	Dead bugs	Total bugs	Dead bugs	Total bugs	Dead bugs
	No.	%	No.	%	No.	%	No.	%	No.	%
Bunch grasses	913	4	228	10	1,738	13	1,394	16	986	19
Timothy	471	trace	25	8	129	21	12	17	174	37

Winter mortality obviously has not greatly reduced the prospect of severe infestations in 1935 in the area covered by this survey. Even with 20 percent reduction in numbers of hibernating bugs, a winter survival of over 200 bugs per square foot of bunch grass would still be indicated for Tippecanoe County. The cause of mortality is not evident. Comparatively few of the dead bugs show macroscopic indications of disease.